



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017,
ANSI/NCSL Z540-1-1994 & ANSI/NCSL Z540.3-2006

MICRO QUALITY CALIBRATION INC.
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CALIBRATION

Valid To: November 30, 2020

Certificate Number: 2348.01

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following calibrations^{1,7}:

I. Chemical

Parameter/Equipment	Range	CMC ^{2, 8} (±)	Comments
pH – Measure & Measuring Equipment ³	4.00 pH 7.00 pH 10.00 pH	0.012 pH 0.012 pH 0.012 pH	Buffer solutions Martek model: Mark 22
Conductivity – Measure & Measuring Equipment ³	11.26 µS/cm 99.60 µS/cm 1410 µS/cm 9987 µS/cm	0.56 µS/cm 2.2 µS/cm 4.7 µS/cm 41 µS/cm	Laboratory standard conductivity solution
Aerosol Particle Counters	(0.3 to 1.0) µm	2.9 %	TSI Electrostatic Classifier 3082 TSI Condensation Particle Counter 3772

II. Dimensional

Parameter/Equipment	Range	CMC ^{2, 6} (\pm)	Comments
Gage Blocks	Up to 4 in (> 4 to 20) in	(2.4 + 1.6L) μ in (3.1 + 1.6L) μ in	Electronic comparator, master steel gage blocks
Micrometer ³	Up to 12 in	(4.8L + 0.6R) μ in	Gage blocks
Caliper ³	Up to 20 in	(4.8L + 0.6R) μ in	Gage blocks
Dial Indicator ³	Up to 4 in	(4.8L + 0.6R) μ in	Gage blocks
Height Gages ³	Up to 40 in	(4.8L + 0.6R) μ in	Gage blocks
Cylindrical Gages – Plug and Pin Gages Plain Ring Gages	Up to 1 in (>1 to 4) in (>4 to 16) in Up to 1 in (>1 to 4) in (>4 to 16) in	(6.8 + 0.7D) μ in (5.4 + 2.2D) μ in (10 + 1.7D) μ in (13 + 0.9D) μ in (13 + 1.2D) μ in (12 + 2.2D) μ in	Universal measuring standard-Supra-500 Universal measuring standard-Supra-500 w/ID probes
Optical Flats	(1 to 8) in	6.0 μ in	Standard optical flat
Thread Wires	(4 to 20) TPI (>20 to 80) TPI	17 μ in 12 μ in	Supermicrometer™ Universal measuring standard-Supra-500
Measuring Microscopes ³	Up to 12 in	(95 + 3.0L) μ in	Glass scale

Parameter/Equipment	Range	CMC ^{2,6} (±)	Comments
Thread Plug Gage – Pitch Diameter	(4 to 20) TPI (>20 to 80) TPI	(28 + 1.5D) μin (24 + 0.5D) μin	Supermicrometer™ Universal measuring standard-Supra-500 w/ thread wires
Major Diameter	(Up to 16) in	(11 + 1.5D) μin	Universal measuring standard-Supra-500
Thread Plug Gage – Minor Lead Angle	(4 to 80) TPI	(95 + 5.4D) μin (31 + 2.6D) μin 0.054 °	Quest thread view machine
Bench Micrometers	Up to 10 in	(12 + 1.3L) μin	Gage blocks
Thread Ring Gage	(80 to 4.5) TPI	(67 + 0.5D) μin	Universal measuring standard-Supra-500 w/ probe
Surface Plate ³ – Flatness	(6 x 6) in to (36 x 72) in	13 μin	Autocollimator
Repeatability		28 μin	Repeat-o-meter
Optical Comparator ³ – X axis Y axis	Up to 12 in Up to 12 in	(46 + 4L) μin (47 + 3L) μin	Gage blocks
Angle	Up to 360°	2.5 min	Angle blocks
Angle Blocks ³	Up to 45°	2.1 arc sec	Sine plate, gage blocks and electronic indicator

Parameter/Equipment	Range	CMC ^{2, 6} (\pm)	Comments
Crimping Tools ³	Up to 1 in diameter	160 μ m	Pin gages, optical comparator, and pull tester
Precision Levels ³	(2 to 15) in	150 μ m	Gage blocks
Protractors/Clinometer ³	Up to 180°	1.3 + 0.6R arc sec	Sine plate w/ angle blocks

III. Dimensional Testing¹

Parameter/Equipment	Range	CMC ^{2, 6} (\pm)	Comments
Length – 1D ⁹	(Up to 40) in	5.2 μ m/in	Gage blocks, CMM, Supra 500, etc

IV. Electrical – DC/Low Frequency

Parameter/Equipment	Range	CMC ^{2, 4, 6} (\pm)	Comments
DC Voltage – Generate ³	Up to 220 mV 220 mV to 2.2 V (2.2 to 11) V (11 to 22) V (22 to 220) V (220 to 1100) V	8.5 μ V/V + 0.40 μ V 5.2 μ V/V + 0.70 μ V 3.7 μ V/V + 2.5 μ V 3.7 μ V/V + 4.0 μ V 5.2 μ V/V + 40 μ V 6.7 μ V/V + 0.40 mV	Fluke 5720A
DC Voltage – Measure ³	Up to 100 mV (0.1 to 1) V (1 to 10) V (10 to 100) V (100 to 1000) V	8.1 μ V/V + 0.45 μ V 5.9 μ V/V + 0.50 μ V 5.9 μ V/V + 1.1 μ V 8.9 μ V/V + 50 μ V 9.6 μ V/V + 0.16 mV*	HP 3458A, option 002 *Add 12 μ V/V \times $(V_{in}/100)^2$ for input >100 V

Parameter/Equipment	Range	CMC ^{2, 4, 5} (\pm)	Comments
DC Voltage – Measure ³ (cont) High Voltage	 (1000 to 10 000) V (10 000 to 70 000) V	 0.042 % + 0.6R 0.048 % + 0.6R	 Vitretek 4700/HLV-70
DC Current – Generate ³	Up to 220 μ A 220 μ A to 2.2 mA (2.2 to 22) mA (22 to 220) mA 220 mA to 2.2 A (2.2 to 11) A (11 to 20) A (20 to 700) A	45 μ A/A + 6.0 nA 53 μ A/A + 7.0 nA 38 μ A/A + 40 nA 48 μ A/A + 0.70 μ A 85 μ A/A + 12.0 μ A 410 μ A/A + 0.48 mA 1.1mA/A + 0.75 mA 1.5 mA/A + 0.52 A	Fluke 5720A Fluke 5720A/Fluke 5725A Fluke 5520A/ Keysight 6680A/HP 3458A/current shunts
DC Current – Toroidal – Type Clamp Meter	(20.5 to 150) A (150 to 1025) A	0.37 % + 0.04 A 0.49 % + 0.09 A	Fluke 5520A w/ Fluke 5500 coils
DC Current – Measure ³	Up to 100 nA 100 nA to 1 μ A (1 to 10) μ A (10 to 100) μ A 100 μ A to 1 mA (1 to 10) mA (10 to 100) mA 100 mA to 1A (1 to 10) A (10 to 20) A (20 to 100) A (100 to 700) A	0.022 % + 60 pA 36 μ A/A + 60 pA 27 μ A/A + 0.14 nA 33 μ A/A + 1.1 nA 32 μ A/A + 7.0 nA 31 μ A/A + 70 nA 50 μ A/A + 0.70 nA 0.014 % + 13 μ A 0.13 % + 0.48 mA 0.16 % + 0.75 mA 0.026 % 0.038 %	HP 3458A, option 002 HP 3458A /current shunts
Resistance – Generate, Fixed Points ³	(1, 1.9) Ω (10, 19) Ω (100, 190) Ω (1, 1.9) k Ω (10, 19) k Ω (100, 190) k Ω (1, 1.9) M Ω	0.011 % 37 $\mu\Omega/\Omega$ 12 $\mu\Omega/\Omega$ 11 $\mu\Omega/\Omega$ 9.5 $\mu\Omega/\Omega$ 24 $\mu\Omega/\Omega$ 43 $\mu\Omega/\Omega$	Fluke 5720A

Parameter/Equipment	Range	CMC ^{2,4,5} (\pm)	Comments
Resistance – Generate, Fixed Points ³ (cont)	10 M Ω 19 M Ω 100 M Ω	43 $\mu\Omega/\Omega$ 71 $\mu\Omega/\Omega$ 0.015 %	Fluke 5720A
Resistance – Measure ³	(0 to 10) Ω (10 to 100) Ω 100 Ω to 1 k Ω (1 to 10) k Ω (10 to 100) k Ω (0.1 to 1) M Ω (1 to 10) M Ω (10 to 100) M Ω	21 $\mu\Omega/\Omega$ + 60 $\mu\Omega$ 20 $\mu\Omega/\Omega$ + 0.60 m Ω 14 $\mu\Omega/\Omega$ + 0.60 m Ω 14 $\mu\Omega/\Omega$ + 6.0 m Ω 14 $\mu\Omega/\Omega$ + 60 m Ω 20 $\mu\Omega/\Omega$ + 3.0 Ω 71 $\mu\Omega/\Omega$ + 0.30 k Ω 0.064 % + 1.2 k Ω	HP 3458A, option 002
Electrical Simulation of Thermocouple ³ –			
Type J	(-210 to -100) $^{\circ}\text{C}$ (-100 to -30) $^{\circ}\text{C}$ (-30 to 150) $^{\circ}\text{C}$ (150 to 760) $^{\circ}\text{C}$ (760 to 1200) $^{\circ}\text{C}$	0.29 $^{\circ}\text{C}$ 0.18 $^{\circ}\text{C}$ 0.18 $^{\circ}\text{C}$ 0.20 $^{\circ}\text{C}$ 0.27 $^{\circ}\text{C}$	Fluke 5520A
Type K	(-200 to -100) $^{\circ}\text{C}$ (-100 to -25) $^{\circ}\text{C}$ (-25 to 120) $^{\circ}\text{C}$ (120 to 1000) $^{\circ}\text{C}$ (1000 to 1372) $^{\circ}\text{C}$	0.34 $^{\circ}\text{C}$ 0.20 $^{\circ}\text{C}$ 0.19 $^{\circ}\text{C}$ 0.29 $^{\circ}\text{C}$ 0.41 $^{\circ}\text{C}$	
Type T	(-250 to -150) $^{\circ}\text{C}$ (-150 to 0) $^{\circ}\text{C}$ (0 to 120) $^{\circ}\text{C}$ (120 to 400) $^{\circ}\text{C}$	0.42 $^{\circ}\text{C}$ 0.25 $^{\circ}\text{C}$ 0.23 $^{\circ}\text{C}$ 0.22 $^{\circ}\text{C}$	
Type N	(-200 to -100) $^{\circ}\text{C}$ (-100 to -25) $^{\circ}\text{C}$ (-25 to 120) $^{\circ}\text{C}$ (120 to 410) $^{\circ}\text{C}$ (410 to 1300) $^{\circ}\text{C}$	0.43 $^{\circ}\text{C}$ 0.26 $^{\circ}\text{C}$ 0.22 $^{\circ}\text{C}$ 0.21 $^{\circ}\text{C}$ 0.30 $^{\circ}\text{C}$	
Type E	(-250 to -100) $^{\circ}\text{C}$ (-100 to -25) $^{\circ}\text{C}$ (-25 to 350) $^{\circ}\text{C}$ (350 to 650) $^{\circ}\text{C}$ (650 to 1000) $^{\circ}\text{C}$	0.51 $^{\circ}\text{C}$ 0.18 $^{\circ}\text{C}$ 0.19 $^{\circ}\text{C}$ 0.19 $^{\circ}\text{C}$ 0.23 $^{\circ}\text{C}$	

Parameter/Equipment	Range	CMC ² (±)	Comments
Electrical Simulation of Thermocouple ³ – (cont)			
Type B	(600 to 800) °C (800 to 1000) °C (1000 to 1550) °C (1550 to 1820) °C	0.45 °C 0.36 °C 0.34 °C 0.37 °C	Fluke 5520A
Type S	(0 to 250) °C (250 to 1000) °C (1000 to 1400) °C (1400 to 1767) °C	0.50 °C 0.37 °C 0.41 °C 0.50 °C	
Type R	(0 to 250) °C (250 to 400) °C (400 to 1000) °C (1000 to 1767) °C	0.59 °C 0.38 °C 0.34 °C 0.43 °C	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Capacitance – Generate ³ , (10 to 1000) Hz	(0.19 to 0.4) nF (0.40 to 1.1) nF (1.1 to 3.3) nF (3.3 to 11) nF (11 to 33) nF (33 to 110) nF	0.54 % + 0.010 nF 0.54 % + 0.010 nF 0.51 % + 0.010 nF 0.26 % + 0.010 nF 0.26 % + 0.10 nF 0.26 % + 0.10 nF	Fluke 5520A
Capacitance – Generate ³ (10 to 1000) Hz (10 to 600) Hz (10 to 300) Hz (10 to 150) Hz (10 to 120) Hz (10 to 80) Hz DC to 50 Hz DC to 20 Hz DC DC DC DC	 (0.11 to 0.33) µF (0.33 to 1.1) µF (1.1 to 3.3) µF (3.3 to 11) µF (11 to 33) µF (33 to 110) µF (0.11 to 0.33) mF (0.33 to 1.1) mF (1.1 to 3.3) mF (3.3 to 11) mF (11 to 33) mF (33 to 110) mF	 0.26 % + 0.30 nF 0.26 % + 1.0 nF 0.26 % + 30 nF 0.26 % + 10 nF 0.41 % + 30 nF 0.47 % + 0.10 µF 0.47 % + 0.30 µF 0.46 % + 1.0 µF 0.46 % + 3.0 µF 0.46 % + 10 µF 0.76 % + 30 µF 1.2 % + 0.10 mF	Fluke 5520A

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage – Generate ³			
Up to 2.2 mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1.0) MHz	0.15 % + 4.0 μV 0.11 % + 4.0 μV 0.09 % + 4.0 μV 0.14 % + 4.0 μV 0.17 % + 5.0 μV 0.23 % + 10 μV 0.51 % + 20 μV 0.59 % + 20 μV	Fluke 5720A/Fluke 5725A
(2.2 to 22) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1.0) MHz	0.040 % + 4.0 μV 0.019 % + 4.0 μV 0.015 % + 4.0 μV 0.034 % + 4.0 μV 0.059 % + 5.0 μV 0.12 % + 10 μV 0.19 % + 20 μV 0.30 % + 20 μV	
(22 to 220) mV	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1.0) MHz	0.026 % + 12 μV 0.010 % + 7.0 μV 0.016 % + 7.0 μV 0.024 % + 7.0 μV 0.049 % + 17 μV 0.095 % + 20 μV 0.14 % + 25 μV 0.29 % + 45 μV	
220 mV to 2.2 V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1.0) MHz	0.025 % + 40 μV 0.010 % + 15 μV 0.0051 % + 8.0 μV 0.0087 % + 10 μV 0.013 % + 30 μV 0.043 % + 80 μV 0.10 % + 0.20 mV 0.18 % + 0.30 mV	
(2.2 to 22) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (300 to 500) kHz (0.5 to 1.0) MHz	0.025 % + 0.40 mV 0.010 % + 0.15 mV 0.005 % + 50 μV 0.086 % + 0.10 mV 0.012 % + 0.20 mV 0.030 % + 0.60 mV 0.10 % + 2.0 mV 0.16 % + 3.2 mV	

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
AC Voltage – Generate ³ (cont)			
(22 to 220) V	(10 to 20) Hz (20 to 40) Hz 40 Hz to 20 kHz (20 to 50) kHz (50 to 100) kHz	0.026 % + 4.0 mV 0.010 % + 1.5 mV 0.0058 % + 0.60 mV 0.011 % + 1.0 mV 0.019 % + 2.5 mV	Fluke 5720A/Fluke 5725A
(220 to 750) V	(20 to 50) kHz (50 to 100) kHz	0.06% + 11 mV 0.23% + 45 mV	
(750 to 1100) V	(15 to 50) Hz 50 Hz to 1 kHz (1 to 20) kHz (20 to 30) kHz	0.031 % + 16 mV 0.008 % + 3.5 mV 0.017 % + 6.0 mV 0.06 % + 11 mV	
AC Voltage – Measure ³			
Up to 10 mV	40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz	0.037 % + 3.1 μV 0.045 % + 3.1 μV 0.15 % + 3.1 μV 0.58 % + 3.0 μV 4.7 % + 4.0 μV	HP 3458A, option 002
(10 to 100) mV	40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz	0.10 % + 2.1 μV 0.018 % + 2.1 μV 0.051 % + 2.1 μV 0.10 % + 2.1 μV 0.35 % + 10 μV 1.2 % + 10 μV	
100 mV to 1 V	40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.2 to 1) MHz	0.010 % + 21 μV 0.018 % + 21 μV 0.037 % + 21 μV 0.095 % + 21 μV 0.35 % + 0.10 mV 1.2 % + 0.10 mV	

Parameter/Range	Frequency	CMC ^{2, 4, 6} (±)	Comments
AC Voltage – Measure ³ (cont)			
(1 to 10) V	(10 to 40) Hz 40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz (100 to 300) kHz (0.3 to 1) MHz	0.010 % + 0.40 mV 0.010 % + 0.21 mV 0.018 % + 0.21 mV 0.037 % + 0.21 mV 0.094 % + 0.21 mV 0.35 % + 1.0 mV 1.7 % + 1.0 mV	HP 3458A, option 002
(10 to 100) V	40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.025 % + 2.1 mV 0.026 % + 2.1 mV 0.043 % + 2.1 mV 0.14 % + 2.1 mV	
(100 to 1000) V	40 Hz to 1 kHz (1 to 20) kHz (20 to 50) kHz (50 to 100) kHz	0.047 % + 21 mV 0.070 % + 21 mV 0.14 % + 21 mV 0.35 % + 21 mV	
High Voltage (1000 to 10 000) V (10 000 to 70 000) V	60 Hz 60 Hz	0.18 % + 0.6R 0.14 % + 0.6R	Vitrek 4700/HLV-70
AC Current – Generate ³			
Up to 220 µA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.028 % + 16 nA 0.019 % + 10 nA 0.016 % + 8.0 nA 0.032 % + 12 nA 0.12 % + 65 nA	Fluke 5720A/Fluke 5725A
220 µA to 2.2 mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.027 % + 40 nA 0.018 % + 35 nA 0.013 % + 35 nA 0.025 % + 0.11 µA 0.11 % + 0.65 µA	
(2.2 to 22) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.028 % + 0.40 µA 0.018 % + 0.35 µA 0.015 % + 0.35 µA 0.024 % + 0.55 µA 0.11 % + 5.0 µA	

Parameter/Range	Frequency	CMC ^{2,4,5} (±)	Comments
AC Current – Generate ³ (cont)			
(22 to 220) mA	(10 to 20) Hz (20 to 40) Hz 40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.028 % + 4.0 µA 0.018 % + 3.5 µA 0.017 % + 2.5 µA 0.026 % + 3.5 µA 0.12 % + 10 µA	Fluke 5720A
220 mA to 2.2 A	20 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.030 % + 35 µA 0.051 % + 80 µA 0.73 % + 0.16 mA	
(2.2 to 11) A	40 Hz to 1 kHz (1 to 5) kHz (5 to 10) kHz	0.50 % + 0.17 mA 0.10 % + 0.38 mA 0.36 % + 0.75 mA	
(11 to 20.5) A	(45 to 100) Hz 100 Hz to 1 kHz (1 to 5) kHz	0.14 % + 5 mA 0.17 % + 5 mA 3.4 % + 0.75 mA	Fluke 5520A
AC Current – Toroidal – Type Clamp Meter			
(20.5 to 150) A	(45 to 65) Hz (65 to 400) Hz	0.48 % + 0.035 A 0.79 % + 0.077 A	Fluke 5520A w/5500 coil
(150 to 1025) A	(45 to 65) Hz (65 to 400) Hz	0.58 % + 0.19 A 1.5 % + 0.35 A	
AC Current – Measure ³			
Up to 100 µA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % + 0.33 mA 0.18 % + 31 nA 0.072 % + 31 nA 0.072 % + 31 nA	HP 3458A, option 002
100 µA to 1 mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % + 0.21 mA 0.18 % + 0.21 mA 0.07 % + 0.21 mA 0.038 + 0.21 mA	
(1 to 10) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % + 2.1 µA 0.17 % + 2.1 µA 0.07 % + 2.1 µA 0.04 % + 2.1 µA	

Parameter/Range	Frequency	CMC ^{2, 4, 5} (±)	Comments
AC Current – Measure ³ (cont)			
(10 to 100) mA	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % + 21 μA 0.07 % + 21 μA 0.17 % + 21 μA 0.04 % + 21 μA	HP 3458A, option 002
100 mA to 1 A	(10 to 20) Hz (20 to 45) Hz (45 to 100) Hz 100 Hz to 5 kHz	0.46 % + 0.21 mA 0.19 % + 0.21 mA 0.10 % + 0.21 mA 0.12 % + 0.21 mA	

Parameter/Equipment	Range	CMC ^{2, 4, 5} (±)	Comments	
Oscilloscopes ³ –				
Amplitude DC Signal Into 50 Ω Load Into 1 MΩ Load	(-6.6 to 6.6) V (-130 to 130) V	0.25 % + 40 μV 0.050 % + 40 μV	Fluke 5520A/SC1100	
Rise Time	< 300 ps	+0 ps/-100 ps		
Leveled Sine Wave Flatness, Relative to 50 kHz 5 mV _(p-p) to 5.5 V _(p-p)	50 Hz to 100 MHz (100 to 300) MHz (300 to 600) MHz 600 MHz to 1.1 GHz	1.5 % + 100 μV 2.0 % + 100 μV 4.0 % + 100 μV 5.0 % + 100 μV		
Time Marker Into 50 Ω Load	(5 to 50) ms 20 ms to 2 ns	(25 + 1000 <i>t</i>) parts in 10 ⁶ 2.5 parts in 10 ⁶		<i>t</i> is time in seconds.
Tachometers ³	(6 to 99 999) RPM	0.004 %		Frequency standard w/LED

V. Electrical – RF/Microwave

Parameter/Range	Frequency	CMC ^{2, 4, 5} (\pm)	Comments
<p>Power Sensor – Calibration Factors</p> <p>(-30 to 20) dBm (-30 to 20) dBm</p>	<p>0.1 MHz to 4.2 GHz 50 MHz to 26.5 GHz</p>	<p>2.8 % <i>CF</i> 3.5 % <i>CF</i></p>	<p>Agilent power sensors 8482A & 8485A</p> <p><i>CF</i> is calibration factor</p>
<p>Amplitude Modulation³ –</p> <p>Carrier: (0.15 to 10) MHz Depth: Up to 99 %</p> <p>Carrier: 10 MHz to 1.3 GHz Depth: Up to 99 %</p>	<p>(20 to 50) Hz 50 Hz to 10 kHz</p> <p>(20 to 50) Hz 50 Hz to 50 kHz (50 to 100) kHz</p>	<p>3.8 % 2.7 %</p> <p>3.8 % 1.6 % 3.8 %</p>	<p>HP 8902A measuring receiver w/ 11722A power sensor</p>
<p>Frequency Modulation³ –</p> <p>Carrier: 250 kHz to 10 MHz Dev: Up to 40 kHz</p> <p>Carrier: 10 MHz to 1.3 GHz Dev: Up to 400 kHz</p>	<p>20 Hz to 10 kHz</p> <p>(20 to 50) Hz 50 Hz to 100 kHz (100 to 200) kHz</p>	<p>2.9 %</p> <p>5.9 % 1.3 % 5.9 %</p>	<p>HP 8902A measuring receiver w/ 11722A power sensor</p>
<p>Phase Modulation³ –</p> <p>Carrier: 150 kHz to 10 MHz</p> <p>Carrier: 10 MHz to 1.3 GHz</p>	<p>200 Hz to 10 kHz</p> <p>200 Hz to 20 kHz</p>	<p>4.8 %</p> <p>3.7 %</p>	<p>HP 8902A measuring receiver w/ 11722A power sensor</p>
<p>Relative Power – Measure³</p> <p>(0 to -10) dBm (-10 to -20) dBm (-20 to -30) dBm (-30 to -40) dBm (-40 to -50) dBm (-50 to -60) dBm</p>	<p>10 MHz to 26.5 GHz</p>	<p>0.08 dB 0.10 dB 0.12 dB 0.13 dB 0.15 dB 0.17 dB</p>	<p>HP 8902A measuring receiver w/ 11722A and 11792A power sensors</p>

Parameter/Range	Frequency	CMC ^{2,4} (±)	Comments
Relative Power – Measure ³ (cont) (-60 to -70) dBm (-70 to -80) dBm (-80 to -90) dBm (-90 to -100) dBm	10 MHz to 26.5 GHz	0.20 dB 0.23 dB 0.28 dB 0.33 dB	HP 8902A measuring receiver w/ 11722A and 11792A power sensors

VI. Magnetic Quantities

Parameter/Equipment	Range	CMC ^{2,5} (±)	Comments
Gauss Meter ³	(0 to 200) Gauss	0.88 %	Helmholtz coil/zero gauss chamber

VII. Fluid Quantities

Parameter/Equipment	Range	CMC ^{2,5,8} (±)	Comments
Flow – Gas ³	(0.5 to 5) sccm (5 to 50) sccm (0.05 to 0.5) lpm (0.5 to 5) lpm (3 to 30) lpm (30 to 100) lpm	1.2 % 1.2 % 0.28 % 0.26 % 0.42 % 0.65 %	DH instruments flow meter calibrator Molbox 1
	(100 to 2500) lpm	1.2 %	Alicat MCR2500SLM
Flow – Liquid ³	(0.02 to 3) gpm (0.5 to 60.0) gpm (1.5 to 160) gpm	0.11 % 0.09 % 0.09 %	Flow technology turbine meter

VIII. Mechanical

Parameter/Equipment	Range	CMC ^{2, 5, 6, 8} (±)	Comments	
Pressure Gauges and Transducer / Vacuum ³	Pneumatic	(0 to 17) psia Up to 600 psig Up to 3000 psig Up to 6000 psig Up to 10000 psig	0.002 % + 0.6R 0.010 % + 0.6R 0.010 % + 0.6R 0.011 % + 0.6R 0.021 % + 0.6R	Mensor CPC 8000 DH Instruments pressure calibrator, PPCA-G
	Hydraulic	(5 to 40 000) psig (725 to 72 500) psi	0.030 % 0.030 %	Ruska Model 2450-701 DH-Budenberg 5306
Torque Analyzers ³	(4 to 50) in·lbf (30 to 400) in·lbf (80 to 1000) in·lbf (20 to 250) ft·lbf (200 to 2000) ft·lbf	0.065 % 0.025 % 0.026 % 0.017 % 0.086 %	Torque arms with Class F	
Torque Tools ³	(1 to 10) in·ozf (10 to 100) in·ozf (4 to 50) in·lbf (30 to 400) in·lbf (80 to 1000) in·lbf (20 to 250) ft·lbf	0.11 % 0.01 % 0.19 % 0.51 % 0.34 % 0.34 %	Mountz MTX10Z AWS: QC10-100 CDI torque, force and tension calibration system, Model: 200-400-02	
Air Velocity Instruments	(25 to 1000) fpm (1000 to 8000) fpm	2.1 % 2.4 %	Omega WT4401-D Petit Tube	
Force Gages and Transducers ³	(1 to 100) lbf	0.28 %	Dead weights	
	(1 to 1000) lbf	0.25 %		
	(350 to 30 000) lbf	0.12 %	Morehouse force machine w/ load cell	
	(5000 to 60 000) lbf	0.99 %	Baldwin hydraulic	

Parameter/Equipment	Range	CMC ^{2, 5, 6, 8} (±)	Comments
Durometer Calibrator – A-Scale D-Scale	(56.08 to 820.87) g (0 to 4.53) kg	2.6 g 0.012 kg	25 lbf load cell
Pipettes	≤10 µL ≤100 µL ≤1000 µL ≤ 5 mL ≤ 10 mL	0.015 µL 0.017 µL 0.040 µL 0.045 µL 0.066 µL	Sartorius CC111, Sartorius WZA 225-CW mass comparator
Indirect Verification of Rockwell Hardness Testers ³	HRA Low Mid High HRBW Low Mid High HRC Low Mid High HR15N Low Mid High HR15TW Low Mid High HR30N Low Mid High	0.31 HRA 0.22 HRA 0.19 HRA 0.60 HRBW 0.50 HRBW 0.68 HRBW 0.56 HRC 0.46 HRC 0.40 HRC 0.54 HR15N 0.47 HR15N 0.61 HR15N 0.29 HR15TW 0.29 HR15TW 0.47 HR15TW 0.35 HR30N 0.52 HR30N 0.57 HR30N	ASTM E18

Parameter/Equipment	Range	CMC ^{2, 8} (±)	Comments
Indirect Verification of Rockwell Hardness Testers ³ (cont)	HR30TW Low Mid High HR45N Low Mid High HR45TW Low Mid High	0.40 HR30TW 0.38 HR30TW 0.34 HR30TW 0.56 HR45N 0.35 HR45N 0.29 HR45N 0.89 HR45TW 0.62 HR45TW 0.61 HR45TW	ASTM E18
Durometers – Type A, B, O Type C, D, DO Indentor Geometry Length Diameter Angle Radius	(0 to 100) DUROS (0 to 100) DUROS Up to 0.2 in Up to 1 in (0 to 90) ° Up to 1 in	0.52 DUROS 0.46 DUROS 0.58 m·in 0.41 m·in 0.049 ° 0.18 m·in	REX-1 durometer calibrator Optical comparator
Acceleration – Sensitivity / Frequency Response	(0.5 to 10) Hz (5 to 10 000) Hz (10 000 to 15 000) Hz	1.7 % 1.9 % 2.2 %	Modal Shop 9155 w/ PCB accelerometers

Parameter/Equipment	Range	CMC ^{2, 5, 8} (±)	Comments
Mass – (Metric)	30 kg 25 kg 20 kg 10 kg 5 kg 3 kg 2 kg 1 kg 500g 300 g 200 g 100 g 50 g 30 g 20 g 10 g 5 g 3 g 2 g 1 g 500 mg 300 mg 200 mg 100 mg 50 mg 30 mg 20 mg 10 mg 5 mg 3 mg 2 mg 1 mg	15 mg 13 mg 10 mg 5.3 mg 2.3 mg 4.9 mg 2.3 mg 1.6 mg 0.57 mg 0.36 mg 0.19 mg 0.19 mg 73 µg 64 µg 6.8 µg 6.1 µg 4.3 µg 4.2 µg 4.5 µg 2.9 µg 2.7 µg 3.2 µg 2.5 µg 2.5 µg 2.4 µg 3.0 µg 2.4 µg 2.4 µg 2.5 µg 2.9 µg 2.5 µg 2.4 µg	Single substitution
Mass – (Avoirdupois)	1 lb 5 lb 10 lb 25 lb 50 lb	2.4 mg 2.4 mg 9.5 mg 4.8 mg 15 mg	Single substitution

VII. Thermodynamics

Parameter/Equipment	Range	CMC ^{2, 5, 6, 8} (\pm)	Comments
Temperature – Measure & Measuring Equipment	(-197 to 0) °C	7.4 mK	SPRT w/ Fluke 1560 Type R TC w/ Tempsens cal-sys 1700
	(0 to 660) °C	5.0 mK	
	(400 to 1600) °C	0.27 % + 0.6R	
Infrared / Pyrometers ³	(50 to 1000) °C	1.3 °C + 0.6R	SBIR 4100G
	(500 to 1600) °C	0.40 % + 0.6R	Tempsens cal-sys1700
Humidity – Measuring Equipment			
(5 to 55) °C	(5 to 80) % RH (81 to 95) % RH	0.5 % 0.7 %	GEO 2000SP & GEO 1000
Temperature – Measuring Equipment, Fixed Point	Triple Point of Water	0.72 mK	Pond Engineering TPW
	Liquid Nitrogen	7.5 mK	
Humidity – Measure ³	(Frost Point)	1.1 °C	Chilled mirror
	(-50 to 90) °C (Dew Point)	0.14 °C	
Dew Point	(100 to -65) °C	0.32 °C	Edge tech 1500
Environmental Chambers	(-80 to 1000) °C	2.0 °C	Type K TCs and Vaisala RH probe

VIII. Time & Frequency

Parameter/Equipment	Range	CMC ^{2, 8} (±)	Comments
Frequency –Measuring Equipment	10 MHz Reference Signal	2.0 parts in 10 ¹⁰ Hz	Datum 9390-6000 w/ GPS
Frequency – Measure	1 MHz to 40 GHz	9.3 parts in 10 ⁹ Hz 1.4 part in 10 ⁷ Hz	10 MHz signal from Datum 9390-6000 w/ GPS to: 53131 counter 5352B counter
Stopwatches	Up to 24 hrs	0.048 s/day	Timometer 4500

IX. Optical Quantities

Parameter/Equipment	Range	CMC ^{2, 5, 8} (±)	Comments
Illuminance – Light meters	(5 to 200) fc (200 to 2000) fc	2.8 % 3.1 %	Hoffman light source with PCS 600 light meter

¹ This laboratory offers commercial dimensional testing and calibration service.

² Calibration and Measurement Capability Uncertainty (CMC) is the smallest uncertainty of measurement that a laboratory can achieve within its scope of accreditation when performing more or less routine calibrations of nearly ideal measurement standards or nearly ideal measuring equipment. CMCs represent expanded uncertainties expressed at approximately the 95 % level of confidence, usually using a coverage factor of $k = 2$. The actual measurement uncertainty of a specific calibration performed by the laboratory may be greater than the CMC due to the behavior of the customer’s device and to influences from the circumstances of the specific calibration.

- ³ Field calibration service is available for this calibration and this laboratory meets A2LA *R104 – General Requirements: Accreditation of Field Testing and Field Calibration Laboratories* for these calibrations. Please note the actual measurement uncertainties achievable on a customer's site can normally be expected to be larger than the CMC found on the A2LA Scope. Allowance must be made for aspects such as the environment at the place of calibration and for other possible adverse effects such as those caused by transportation of the calibration equipment. The usual allowance for the actual uncertainty introduced by the item being calibrated, (e.g. resolution) must also be considered and this, on its own, could result in the actual measurement uncertainty achievable on a customer's site being larger than the CMC.
- ⁴ The stated measured values are determined using the indicated instrument (see Comments). This capability is suitable for the calibration of the devices intended to measure or generate the measured value in the ranges indicated. CMC's are expressed as either a specific value that covers the full range or as a percent or fraction of the reading plus a fixed floor specification.
- ⁵ In the statement of CMC, percentages are to be read as percent of reading, unless noted otherwise.
- ⁶ In the statement of CMC, L is the numerical value of the nominal length of the device measured in inches, R is the numerical value of the resolution of the device under test in microinches, D is the numerical value of the nominal diameter of the device measured in inches.
- ⁷ This scope meets A2LA's *P112 Flexible Scope Policy*.
- ⁸ The type of instrument or material being calibrated is defined by the parameter. This indicates the laboratory is capable of calibrating instruments that measure or generate the values in the ranges indicated for the listed measurement parameter.
- ⁹ This laboratory meets *R205 – Specific Requirements: Calibration Laboratory Accreditation Program* for the types of dimensional tests listed above and is considered equivalent to that of a calibration.



Accredited Laboratory

A2LA has accredited

MICRO QUALITY CALIBRATION INC.

Chatsworth, CA

for technical competence in the field of

Calibration

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This laboratory also meets the requirements of ANSI/NCSLI Z540-1-1994 and the requirements of ANSI/NCSLI Z540.3-2006 and R205 – Specific Requirements: Calibration Laboratory Accreditation Program. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated April 2017*).



Presented 21st day of February 2019.

A blue ink signature of the Vice President of Accreditation Services.

Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 2348.01
Valid to November 30, 2020

For the calibrations to which this accreditation applies, please refer to the laboratory's Calibration Scope of Accreditation.